Canadian Aviation Safety Board

Bureau canadien de la sécurité aérienne

Civil Aviation Occurrence Report

Canada

The Canadian Aviation Safety Board investigated this occurrence for the purpose of advancing aviation safety. It is not the object of the Board to determine or apportion any blame or liability.

AVIATION OCCURRENCE REPORT

TRILLIUM AIR
BRITTEN-NORMAN BN2A-20 ISLANDER C-GIRH
TORONTO ISLAND AIRPORT, ONTARIO 3.5 mi SSE
12 JANUARY 1987

REPORT NUMBER 87-Ø70004

SYNOPSIS

The aircraft was on a day visual flight rules (VFR) flight from St. Catharines to Toronto, Ontario, when both engines lost power. The pilot ditched the aircraft into Lake Ontario, 3.5 miles south-southeast of the Toronto Island Airport. Both occupants were recovered from the water, suffering from hypothermia. The passenger survived, but the pilot died.

The Canadian Aviation Safety Board determined that the pilot undertook the flight with insufficient fuel. Also, as the survivors did not have effective signalling devices, rescue was delayed because rescue agencies had difficulty locating the survivors on the rough water surface.

Ce rapport est également disponible en français.

15 September 1988

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1.0 FACTUAL INFORMATION

1.1 History of the Flight

On 12 January 1987, a Britten-Norman BN2A-20 aircraft, C-GIRH, operating as Trillium Flight 123, departed the St. Catharines Airport at 1049 eastern standard time (EST)* on a 28 nautical mile visual flight rules (VFR)** flight to the Toronto Island Airport. The flight was the return leg of a flight that had originated from Toronto on the same morning for the purpose of retrieving and transporting company equipment from St. Catharines to Toronto. On board were the pilot and one passenger, the company vice-president.

No flight plan had been filed for the flight. The route chosen by the pilot was St. Catharines direct Toronto Island, which placed the aircraft over Lake Ontario for most of the flight. Approximately half-way across the lake, the aircraft's left engine suddenly began to lose power, cutting in and out, and then stopped. At 1103 EST, the pilot contacted the Toronto Island Tower stating he was about three miles to the southwest and requesting landing instructions for runway 08. Approximately one minute later, he transmitted an urgent message stating that he would like to land on runway 03.

The air traffic controller confirmed that the pilot was requesting to land at the Toronto Island Airport and, after enquiring about the pilot's difficulty, cleared the pilot to land on any runway he wanted. The pilot stated he was experiencing engine problems due to carburettor icing and was about one and one-half miles out for runway 33. The controller contacted the radar departure controller at Toronto/Lester B. Pearson International Airport requesting identification of Trillium Flight 123 on radar; radar contact could not be established. At 1106, the pilot transmitted a distress message stating that he was going to ditch the aircraft in the water and estimated he was about three quarters of a mile final for runway 33. The last transmission from the aircraft was at 1108 when the pilot reported that the aircraft was floating on the lake. The aircraft sank about eight minutes later. Approximately one hour after the aircraft sank, both occupants were located; they were wearing their

* All times are EST (Coordinated Universal Time (UTC) minus five hours) unless otherwise stated.

** See Glossary for all abbreviations and acronyms.

life-preservers and suffering from hypothermia. The passenger was rescued by helicopter and the pilot by boat. Both were transported to a hospital by helicopter where the pilot died.

The accident occurred at 1108 EST during the hours of daylight, approximately three and one-half miles south-southeast of the Toronto Island Airport at lat 43°35'N, long 79°19'W***, at an elevation of 250 feet above sea level (asl) (see Appendix A).

Note: A detailed summary of the sequence of events is contained in Appendix C.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	1	-	-	1
Serious	-	1	-	1
Minor/None	-	-	-	-
Total	1	1	-	2

1.3 Damage to Aircraft

The aircraft was substantially damaged.

1.4 Other Damage

- Nil -

1.5 Personnel Information

	Pilot-In-Command
Age	38
Pilot Licence	Airline Transport
Medical Expiry Date	01 May 1987
Total Flying Time	2,112 hr
Total on Type	96 hr
Total Last 90 Days	57 hr
Total on Type Last 90 Days	7 hr
Hours on Duty Prior to Occurrence	1 hr
Hours off Duty Prior to Work Period	Had not flown since 09 January 1987

*** Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.

The pilot-in-command was occupying the left front seat and was at the controls of the aircraft at the time of the occurrence. He had undergone company pilot training on Britten-Norman-type aircraft in August 1986, after which he underwent a successful Department of Transport pilot proficiency check-ride to captain status on the aircraft.

1.6 Aircraft Information

Manufacturer	Britten-Norman
Type	BN2A-20 Islander
Year of Manufacture	1974
Serial Number	404
Certificate of Airworthiness	12 June 1986
Total Airframe Time	9,517 hr
Engine Type (2)	Lycoming IO-540-K1B5
Propeller Type (2)	Hartzell HC-C2YK-2CUF
Maximum Allowable Take-off Weight	6,600 lb
Recommended Fuel Type	100/130 aviation gasoline

The Britten-Norman BN2A-20 is an all metal, high cantilever wing monoplane with a fixed tricycle landing gear. This aircraft has a maximum gross weight for take-off of 6,600 pounds and is powered by two, wing-mounted, fuel-injected engines, each rated at 300 horsepower. The aircraft cabin was configured to accommodate two crew seats and eight forward-facing passenger seats.

The weight and centre of gravity were within the prescribed limits.

The accident aircraft was imported from the U.S.A. and entered Canada on 03 May 1986. On 16 June 1986, following an inspection for the issuance of the Certificate of Airworthiness, an interim Certificate of Airworthiness was issued. At this time, the aircraft had a total of 9,178 hours air time listed in the Journey Log Book. The aircraft had been maintained in accordance with the department's standards and the manufacturer's progressive maintenance check-list.

The last 50-hour check had been carried out on 27 September 1986 at a total time of 9,497 hours. Since that time, the aircraft had flown approximately 20 hours. Prior to the last flight, a vent motor was overhauled and reinstalled, the brake fluid was topped up, the engines were ground run, and the aircraft was signed out by an aircraft maintenance engineer. All applicable airworthiness directives, service letters,

and bulletins had been complied with, and there was no record of any deferred maintenance or unserviceabilities with the aircraft.

The last time the aircraft was refuelled was 19 November 1986, at which time it was fuelled to capacity with 100 octane fuel. Prior to the accident flight, it was last flown on 21 November 1986. From the date of the last refuelling to the date of the accident, including the time flown on that date, the aircraft had flown on five flights for a total air time of three hours. During this same time period, a ground run of approximately 20 to 30 minutes had been carried out by a maintenance engineer. Before the flight on the accident date, the pilot ran the aircraft engines for approximately 10 to 15 minutes prior to taxiing for take-off. The engine manufacturer's fuel consumption charts indicate a fuel consumption of 16.5 U.S. gallons per hour per engine at a cruise power setting of 65 per cent. Fuel consumption for take-off and climb power settings is 24 U.S. gallons per hour and 19 U.S. gallons per hour per engine respectively.

1.6.1 Aircraft Modifications

Two fuel-injected Lycoming Model I0540-K1B5 engines (Modification NB/410) had been installed on this aircraft. This factory modification introduces more powerful engines equipped with fuel injection, new induction systems, modified exhausts, and redesigned engine baffles. The new induction air box assemblies (to supply hot or cold air to the fuel injectors) use the original carburettor heat flexible cables and pilots' console control levers. The lever identity markings remain CARB HEAT, as there is no provision with the modification to relabel them INDUCTION HEAT. The aircraft was also modified to reduce the unusable fuel from nine U.S. gallons per tank to three and one-half U.S. gallons per tank (Modification NB/M240).

1.6.2 Aircraft Fuel System

The aircraft's fuel system consists of two integral tanks within the wing (see Appendix B). Each tank holds 68.5 U.S. gallons of fuel, of which 65 U.S. gallons are usable, for a total of 130 U.S. gallons. Within each tank, located at the rear of the tank, is a fuel contents transmitter unit which is electrically connected to a fuel quantity indicator on the overhead instrument panel. The accident aircraft fuel gauges were reported to be serviceable. Post-crash functional testing of the aircraft fuel gauges was not possible because of water damage. Normal fuel feed is from left tank to left engine and from right tank to right

engine. Fuel is drawn from a sump beneath the tank and is delivered by pumps, via a three-way fuel cock and a line filter (gascolator) to the fuel injection unit. Interconnecting pipelines between the left and right fuel cocks enable either engine to be fed by either fuel tank, if necessary, according to selection.

Fuel pumping facilities for each engine are a continuously operating engine-driven pump and an electric pump mounted on the rear spar at the inboard end of each fuel tank. The two boost pumps serve for take-off, climb, and landing procedures and as emergency pumps in the event of an engine-driven pump failure.

A fuel sump is attached to the underside of the wing, below each tank. Pipeline connections, enclosed within a detachable fairing, are made between the rear sealing plate of the sump and the underside of the wing. The sealing plate is detachable, thus allowing access to interior of the sump and to the suction filter at the base of the sump. A fuel drain plug and a water drain valve are located in the base of each sump. Approximately 0.75 U.S. gallons of each tank's contents are undrainable.

1.7 Meteorological Information

At 1200Z (0700 EST) 12 January 1987, a weak frontal wave was located just south of Muskoka, with a warm front southward from the wave and a cold front westward. The wave was 20 nautical miles east of Toronto by 1300 EST, with the warm front of the wave through Buffalo and the cold front through southern Lake Huron.

Cloud associated with the frontal wave over the western end of Lake Ontario was generally based at 2,500 feet asl. Visibilities over the lake were generally adequate for VFR flight, and the snow showers that were present were reported to be widely scattered, thus permitting easy circumnavigation of the precipitation areas.

Weather conditions along the route of flight and at destinations were generally overcast skies with lower broken cloud cover. Very light scattered rain showers or snow showers were present, lowering visibilities to five or six miles; however, general visibilities were 15 miles or better.

The 1600Z (1100 EST) Toronto Island weather observation was as follows:

> Estimated cloud 2,000 ft broken, 4,000 ft overcast; visibility 15+ mi with very light rain showers; wind 290° at 8 gusting to 17 kt; temperature +2°C, dew point -1°C; Lake Ontario water temperature +2°C, with waves reported to be 4 to 6 ft.

Actual and forecast weather reports are available at the St. Catharines Airport and Toronto Island Airport. The pilot was observed in the weather office at both locations obtaining weather information by a self-briefing method.

1.8 Aids to Navigation

The aircraft was conducting a straight-in visual approach to runway 33. There are no approach aids to this runway. A non-directional radio beacon is located at Gibraltar Point, one nautical mile from the airport.

1.9 Communications

The aircraft was in communication with the Toronto Island Control Tower on frequency 118.2 megahertz (MHz). Communications prior to and at the time of the occurrence were carried out without difficulty.

1.10 Aerodrome Information

The Toronto Island Airport is operated by the Toronto Harbour Commission and is publicly licensed. Runway 33, which has an asphalt surface, is 3,000 feet long by 150 feet wide; there are no obstructions on the approach path to the runway. Runway surfaces were reported as bare and dry.

The airport control zone extends for a three-mile radius from the airport centre, with vertical limits below 2,500 feet asl. The control zone is controlled by an air traffic services control tower which was in operation and staffed in accordance with normal operations at the time of the occurrence.

1.10.1 Crash Firefighting and Rescue Services

Toronto Island Airport is in receipt of airport financial assistance (subsidy) from Transport Canada but is not operated by, or for, Transport Canada. Although there are no statutory requirements for Crash

Firefighting and Rescue (CFR) services to be provided at any airport not operated by Transport Canada, Transport Canada encourages certain subsidized airports that serve a significant number of air carrier passengers to provide CFR where such services can be effectively and economically provided.

The Transport Canada category of CFR services to be provided at an airport is determined from the type (length) of aircraft and the frequency of movements by scheduled air carriers. The category establishes the level of CFR vehicles and the number of qualified personnel to be available during established operational hours, for immediate response to an incident.

At the time of the occurrence, Toronto Island Airport was operating as a CFR Category II airport, that is, it required one fire vehicle containing 650 litres of water and 90 kilograms of dry chemical. Had this been a Transport Canada airport, based on the number of movements by the largest type of aircraft operating at the airport, the airport would have been designated as a CFR Category V airport. In order to maintain a Category V level, Toronto Island Airport would have had to operate a vehicle containing 5 500 litres of water and 180 kilograms of dry chemical, plus one rapid intervention vehicle (RIV).

CFR response at the Toronto Island Airport is coordinated via direct line from the Toronto Island Control Tower. One CFR vehicle and three trained personnel are on stand-by during normal working hours (0700 to 1530), five days a week, with two trained personnel from 1530 to 2330 on holidays and weekends.

When the pilot of Trillium 123 reported he was encountering difficulties, Toronto Island Tower requested the CFR equipment to stand by. CFR responded by proceeding to the threshold of runway 33, which was the intended runway for landing.

1.10.2 Direction Finding Equipment

Direction finding (DF) equipment, when installed in a control tower, enables controllers to determine an aircraft bearing from the tower. DF information is electronically derived from radio signals transmitted from the aircraft. Since very high frequency (VHF) transmissions are restricted to line-of-sight, altitude and location of the aircraft may limit coverage. As in all radio communication, the power of the transmitted signal will affect reception distance. Information may

be obtained from either a modulated signal (speech transmission) or an unmodulated signal (mike button pressed - no speech). The length of the transmission is not critical since information can be obtained from a very short transmission (two seconds).

The purpose of the DF installation is to provide directional assistance to VFR aircraft. This equipment is not intended as a substitute for normal VFR navigation, but rather as an aid in times of difficulty. Where radar is available, it is the preferred means of providing assistance.

The Toronto Island Airport is not equipped with DF equipment; however, radar service for the area is provided by Toronto/Lester B. Pearson International Airport. This radar, though, may not be able to detect small aircraft flying at altitudes below approximately 1,000 feet asl in the vicinity of the airport. Air traffic controllers at the Toronto Island Airport can communicate by direct land line with the radar controllers at Toronto/Lester B. Pearson International Airport.

1.10.3 Water Rescue Capabilities

The airport disaster/emergency plan, although in a draft stage as of 12 January 1987, required the Toronto Island Tower to respond to a notification of a crash in the water by requesting the assistance of the Metropolitan Toronto Police Marine Unit located on the Toronto Harbour waterfront if a vessel is required. The unit may be contacted via a direct telephone from the Toronto Island Control Tower. The unit is staffed 24 hours a day, seven days a week, with several boats in the water during summer months. During winter months, the unit has at least two boats in the water, which can respond provided the harbour is not icebound.

1.11 Flight Recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was either required by regulation.

1.12 Wreckage and Impact Information

The aircraft ditched in Lake Ontario while on a northerly heading and sank approximately eight minutes after the ditching. Four- to six-foot waves were reported at the time of the ditching. No damage occurred to the aircraft cockpit or cabin area during the water landing.

On 07 April 1987, using an MRD-1 Tellurometer Positioning System and Sonar Side-Scanning equipment, investigators located the aircraft on the bottom of Lake Ontario at lat 43°35'N, long 79°20'W, in approximately 270 feet of water.

On 09 April 1987, remote video camera equipment was lowered, and the aircraft was videotaped from the lake surface. The videotape revealed that the aircraft was relatively undamaged and resting upright on the muddy lake bottom, with the landing gear wheels buried in the mud.

On 11 June 1987, the aircraft was raised from the lake bottom in a wings-level, right-side up attitude. It was then placed on a barge and transported to a hangar at the Toronto Island Airport for examination.

The nose section of the aircraft fuselage was crushed upward and rearward, and the fuselage skin was wrinkled the full length of the aircraft belly. The aft section of the fuselage sides had been crushed. Both propellers were undamaged and in an unfeathered pitch position. The anti-feathering pins will prevent the propeller from feathering if the propeller levers are selected to the feather position and the rpm is below 600 to 700 rpm. The tail surfaces and main landing gear were undamaged, and the nose landing gear had been pushed rearward. The wing trailing edge flaps were extended 10 degrees.

The top and bottom of both fuel tanks were crushed inward, and both sumps had ruptured. The remainder of the aircraft fuel system was intact and undamaged. The fuel tank caps were both in place and secure.

The aircraft cockpit and cabin area were undamaged, except for water damage.

The left and right electric fuel pumps were found selected ON, with the left fuel selector in the CROSS-FEED position and the right fuel selector in the ON position. The left and right propeller pitch levers were in the feather DETENT position, and the left and right mixture control levers were in the IDLE CUT-OFF position. The induction heat control levers were in the COLD position. The left and right generator switches were selected ON. The left and right engine magneto switches were selected OFF, and the cabin heater and cabin air fan switches were selected ON.

1.13 Medical Information

1.13.1 Medical Findings

The pilot's most recent aviation medical examination was performed on 16 October 1986. He was assessed fit to Transport Canada Category I Standards.

There was no evidence that incapacitation, physiological, or psychological problems affected the pilot's performance.

1.13.2 Pathological Findings

Post-mortem examination of the pilot revealed that attempts had been made to resuscitate him. There was no evidence of disease or any signs of trauma due to impact. Cause of death was attributed to hypothermia.

1.13.3 Toxicological Findings

Toxicological samples included specimens of blood and tissues, but not urine. Laboratory examination conducted at the Civil Aviation Medical Unit (CAMU) on 02 February 1987 produced the following results:

Ethyl alcohol	Negative
Carbon monoxide	Negative
Hydrogen cyanide	Negative
Drugs	Caffeine, Lidocaine, Trace amount (0.6 ng/ml) of Tetrahydrocannabinol (THC)

A second and independent laboratory examination was conducted at the Centre of Forensic Sciences on 24 March 1987. The findings included caffeine, lidocaine (used in hospitals to stabilize the heart beat) and cannabinoids, but not THC.

1.14 Fire

There was no evidence found of fire either before or after the occurrence.

1.15 Survival Aspects

The aircraft impact forces were survivable, and both occupants were uninjured as a result of the ditching. The aircraft was equipped with seat-belt restraint systems, which were in use, and life-preservers which both occupants were able to don before the aircraft sank. The life-preservers were an approved type manufactured in accordance with Technical Standard Order (TSO) C13d.

The emergency locator transmitter (ELT) was recovered, and the function switch was found in the OFF position. There were no day signalling devices available such as flares, smoke, or dye in the aircraft. Present Transport Canada requirements for overwater flights of this nature do not require any type of water survival equipment to be on board the aircraft. Air Navigation Order Series II, No.8, Order Respecting Life-Saving Equipment for Aircraft Operating Over Water, states in part that multi-engined aircraft capable of single-engine flight and while flying within 50 nautical miles of land, do not require life- preservers for the occupants. The flight on 12 January was carrying life-preservers even though not required by this Order.

Interpretation of the results of experiments with hypothermia subjects has shown that, in water having a temperature of plus two degrees Celsius, as it was in this case, the average male person in street clothes can survive for about 1 hour and 10 minutes. A water temperature of +10 degrees Celsius would increase predicted survival time to two and one-half to three hours.

1.16 Tests and Research

1.16.1 Fuel System

The fuel systems on both aircraft engines were checked, and the contents of the fuel lines were drained into containers and sealed on 11 June 1987. The fuel tanks and lines from the fuel tanks to the aircraft gascolator bowls were found empty of any fluids. The quantities and type of fluids recovered from other parts of the two systems are listed in the following table:

Component	Left Engine QTY	(ml)	Type of Fluid	Right Engine QTY	(ml)	Type of Fluid
Gascolator Bowl	Full		Water	Full		Water and 100 Octane fuel
Fuel line gascolator bowl to engine-driven fuel pump	30	75*	Water and air	22	57*	100 Octane fuel and air
Fuel line from engine-driven fuel pump to injector unit	3.4	13.5*	100 Octane fuel trace of water and air	0	13.5*	Trace of liquid with muddy substance and air
Fuel line from fuel-injector unit to fuel distributor	5.5	6.0*	100 Octane fuel and trace of water	2.2	6.0*	100 Octane fuel
Fuel-injector lines (six)	0		Air	0		Air

* Note: Maximum fluid capacity of line.

The samples of liquid recovered from the fuel gascolator bowls were taken to a water laboratory for examination in an attempt to determine the origin of the water portions of the liquids. The origin of the water could not be determined; however, it was found not to be totally representative of Lake Ontario water in the vicinity of Toronto. Because of low conductivity and calcium and magnesium concentration, it is likely that the sample represents a mixture of condensation and lake water.

The cabin heater fuel filter bowl was dismantled and found to contain only water. The gascolator screen filters, fuel-injector finger screen filters, and heater fuel filter were examined; they did not contain any visible contaminants that would block fuel passage.

The fuel lines and cross-feed system were checked; there was no evidence of fuel blockage or a pre-impact malfunction.

1.17 Additional Information

1.17.1 Pre-Flight Activities

The flight was a company non-revenue flight for the purpose of retrieving company equipment no longer in use from the St. Catharines Airport and transporting it to Toronto Island Airport. After this flight, the aircraft was to be flown to Oshawa Airport for storage as the company did not have plans for the immediate use of the aircraft. The flight was scheduled for departure from Toronto Island at 0830 EST; however, it was delayed approximately one hour when the pilot was late arriving at the airport because of heavy road traffic.

Trillium Air operated a scheduled passenger service between Toronto Island and St. Catharines Airports until October 1986. As a result of this operation, air traffic control personnel at both airports were familiar with the Trillium aircraft and company personnel.

The aircraft had not flown since 21 November 1986; consequently, on 09 January 1987, in preparation for the 12 January flight, the company engineer checked the aircraft over, drained the fuel sumps, and ran the aircraft engines until temperatures and pressures stabilized in the operating ranges, thus satisfying himself the aircraft was fit to fly. It was his understanding that the aircraft was going to be flown directly to Oshawa on 12 January. The engineer had not spoken to the pilot after he prepared the aircraft on 09 January.

The pilot, in preparation for the flight, visited the weather office at Toronto Island on the morning of 12 January 1987. He was observed studying the hourly weather observations and forecasts. The Toronto Island weather office, although attended by a weather specialist, is primarily a self-briefing type weather office. No flight plan, flight notification, or flight itinerary had been filed for the Toronto/ St. Catharines/Toronto legs of the flight, as is required by regulation. The company engineer had proceeded to Oshawa by automobile in order to help with storage arrangements for the aircraft and to transport the pilot back to Toronto.

1.17.2 Fuel Computations

No fuel was placed on board the aircraft, nor did the pilot request fuel prior to departure from Toronto Island or St. Catharines Airports.

From 19 November 1986, the date of the last fuelling, to the date of the accident, including the time flown on that date, the aircraft had flown on five flights for a total air time of three hours. During this same period, a ground run of approximately 20 to 30 minutes had been carried out by a maintenance engineer, and, prior to the flight on the accident date, the pilot had ground run the aircraft engines for about 10 minutes before taxiing for take-off. Three of the above-mentioned flights were for pilot training.

A computation of the fuel used since the last fuelling in November 1986, based on analysis of the Aircraft Journey Log Book air time entries, fuel records obtained from fuel agencies, and aircraft engine manufacturer information is shown below. The computations assumed a fuel consumption rate of 16.5 U.S. gallons per hour per engine at 65 per cent cruise power with the engines leaned.

Date	Air Time	Fuel Burn at Cruise Power Settings
19 Nov.	1.0 hr	198.0 lb
19 Nov.	.6 hr	118.8 lb
21 Nov.	.8 hr	158.4 lb
12 Jan.	.3 hr	59.4 lb
12 Jan.	.3 hr	59.4 lb
Total	3.0 hr	594.0 lb

Before the first flight on 19 November 1986, there was a full load of fuel on board, that is, 130 U.S. gallons of usable fuel (780 pounds). The above fuel calculations do not include the fuel consumed for start-up, taxi, run-up, take-off, and climb, nor do they include the fuel consumed during the 20- to 30-minute ground run on 09 January 1987.

The company engineer reported that there was about one-quarter fuel remaining in each tank, that is, about 16 U.S. gallons in each tank for a total of about 190 pounds, based on his observations of the aircraft fuel gauges on 09 January 1987 prior to the first flight on 12 January 1987.

1.17.3 Search and Rescue (General)

Search and Rescue in the area where the aircraft ditched is within the response area of the Trenton Search and Rescue Coordination Centre (RCC). The centre is located at the Canadian Forces Base Trenton, 87 nautical miles east of Toronto, and is staffed on a

24-hour, seven-day a week basis. Assistance from the RCC Unit may be obtained by telephone either by dialing a toll-free number or calling collect. Fixed-wing and helicopter aircraft, with specialized rescue equipment and trained rescue personnel, are available on a 30-minute response time Monday to Friday, 0800 to 1630, and on a two-hour response time at all other times including holidays. In addition to equipment located at Trenton, the RCC maintains, through a civil/military communication network, the whereabouts of federal government and municipally operated vessels on the Great Lakes and has the authority to request and obtain the services of these vessels and/or aircraft for the purpose of search and rescue.

1.17.4 RCC Response

Toronto Area Control Centre did not inform the RCC upon notification of the accident as is required by the Manual of Operations (MANOPS). About 12 minutes after the accident, RCC was notified by the Metropolitan Toronto Police Marine Unit. Upon notification, RCC immediately tasked a Labrador helicopter to respond. A few minutes later, after receiving additional information regarding the occurrence, a Buffalo aircraft was also tasked. The RCC issued a request for assistance on the Marine Radio Band for any surface craft in the vicinity of the accident site to respond. At Pickering, a Canadian Coast Guard rescue boat (SAR 1) was tasked by the RCC to proceed to the accident site. After the RCC on-scene commander arrived, he assessed the situation and, based on the fact that the passenger was being transported to Sunnybrook Hospital by helicopter and knowing the capabilities of the on-scene military rescue helicopter, decided to transport the pilot to Sunnybrook Hospital by military rescue helicopter. He also advised the hospital of the estimated time of arrival of the rescue helicopter.

1.17.5 Fixed-Wing Aircraft Response

A Cessna model 152 aircraft (C-GYJK), with an instructor and student pilot on board, responded by offering assistance and proceeded to the area where Trillium Flight 123 last reported. The pilot was successful in locating the downed aircraft in the water just before it sank but lost sight of the accident pilot and passenger after the aircraft sank. The pilot continued to circle in the area until the arrival of the responding agencies.

1.17.6 Helicopter Response (Local Commercial Operator)

Ranger Helicopters, a local commercial helicopter operator based at the Toronto/Cherry Beach heliport, was notified of the occurrence and requested to assist. The operator responded by dispatching an Aerospatiale AS 350B (Astar) helicopter, C-GATX, to assist in the search and rescue operation. The helicopter was not equipped with any specialized rescue equipment.

During the search, the pilot had to land for a few minutes to let a snow shower pass through the area, before resuming the search. The pilot was successful in locating the survivors in the water, approximately one hour after the aircraft sank. He attempted to rescue a survivor from the water by use of a rope but was unsuccessful.

1.17.7 Helicopter Response (Ontario Provincial Police)

The Ontario Provincial Police helicopter section, located at Brampton, Ontario, was requested to assist and responded by dispatching a Bell 206B helicopter, C-GOXY. This helicopter was equipped with a "Billy Pugh" style net which is used for water rescue. The net is carried inside the helicopter cabin while the helicopter is in transit to a search area and during the search. When required for rescue, the helicopter lands, and the net is attached to the helicopter hoisting gear on the belly of the helicopter.

The crew of the police helicopter coordinated the helicopter portion of the search and rescue until the arrival of the Trenton Search and Rescue personnel.

1.17.8 Helicopter Response (Ontario Ministry of Health Air Ambulance)

The Ontario Ministry of Health Air Ambulance section, located at the Toronto/Buttonville Airport, was requested to assist and responded by dispatching a Messerschmitt BK117-A-3D helicopter, C-GIRB. This helicopter was not equipped with any specialized rescue equipment.

The crew on this helicopter was successful in rescuing the passenger from the water and transporting him to the Sunnybrook Hospital. Rescue was accomplished by the pilot hovering the helicopter with the skid close enough to the passenger so that he could climb onto it. The passenger was unable to do this by himself, and one of the air ambulance medical officers climbed out onto

the skid, assisted the victim onto the skid, and held him there while the pilot air taxied the helicopter to shore where the passenger was placed inside the helicopter cabin.

1.17.9 Water Rescue

The Metropolitan Toronto Police Unit was notified of the occurrence by the Toronto Island Tower. The Marine Unit responded initially with one boat and later with a second boat that subsequently was not required and returned to the marine base. After the passenger had been rescued by the air ambulance helicopter crew, the police marine unit located and pulled the accident pilot into the boat and began treatment on him. The pilot was taken ashore, transferred to a military rescue helicopter, and flown to Sunnybrook Hospital.

1.17.10 Communications During the Search and Rescue

During the initial stages of the air and surface search, the control tower was the sole communication link with the various agencies that responded. There was no means of direct communication available between the Island control tower and the police marine boat nor between the aircraft and the police boat. All communication with the boat had to be carried out by direct telephone line to the police marine base and then relayed to the boat via police radio.

Once the four helicopters were in the search area, the helicopter pilots decided to communicate on a separate frequency (122.9) and organize the search on that frequency.

1.17.11 Toronto Island Airport Disaster/Emergency Plan

The Transport Canada policy relative to water rescue requires that the airport disaster/emergency plan provide for water rescue capabilities when airport sites are located near large bodies of water.

In February 1986, Toronto Island Airport was officially designated a category requiring that emergency plans be established to deal with hijacking, bomb threats, and explosives. Along with these measures, emergency plans were also to include crashes on and off the airport; structural fires; disasters; hazardous materials, etc., and were to be incorporated in accordance with Policy, Standards, and Guidelines for the Development of an Airport Disaster Emergency Plan and the Conduct of Exercises at Transport Canada Airports.

On 03 to 04 March 1986, a review of airport security at Toronto Island Airport was conducted by Transport Canada, at which time it was noted that there were no disaster/emergency plans for the airport.

In September 1986, a copy of the first draft of the Toronto Island Airport Emergency Procedures Manual was received at Transport Canada. Concurrently, a telephone call was received from the CFR Chief, inviting Transport Canada participation at an initial meeting of Toronto Island Airport occupants and emergency support services to discuss the content of the draft Toronto Island Airport Security Plan and the draft emergency procedures manual.

On 19 September 1986, the aforementioned meeting was held at Toronto Harbour Commission offices. Several of the plan deficiencies were identified at that time, and a review of the airport management responsibilities was conducted. Further, it was resolved that, because of the disparity between who could provide what service, the CFR Chief was to liaise with each tenant and emergency support service separately to refine the individual responsibilities and requirements.

As of 12 January 1987, the Toronto Island Airport Emergency Procedures Manual was in a draft stage and was awaiting final approval by Transport Canada.

1.17.12 Life-Saving Equipment - Toronto Harbour

The various agencies who operate surface vessels in and around the Toronto Harbour area carry limited life-saving equipment that is integral to their operation. There are no dedicated resources such as life-rafts or hovercraft readily available in the vicinity of the Toronto waterfront to be transported by air or water in the event that a water rescue is required.

1.17.13 Categorization of Hospitals by Specialty

Hospitals with specialized treatment centres for specific injuries such as burns, hypothermia, and trauma are not well known to emergency response agencies. Certain hospitals have a better capability to deal with certain types of injuries; however, there is no published information to this effect available to rescuers.

1.17.14 Public Inquiry

As part of the investigation process, the CASB conducted a four-day public inquiry into the accident in Toronto, beginning on 23 March 1987. Participants in the inquiry were the CASB technical panel; Trillium Air; representatives of the next of kin; Pilatus Britten-Norman Ltd.; Avco Lycoming Textron, Williamsport Division, Textron Inc.; Toronto Harbour Commissioners; Ontario Provincial Police; Metropolitan Toronto Police; Ministry of Health of Ontario; Department of National Defence; Department of Transport, Canada; and the Chief Coroner of Ontario. Appendix D provides the list of witnesses who testified at the inquiry.

1.18 Useful or Effective Investigation Techniques

1.18.1 Locating and Recovery of Wreckage

The operation consisted of three phases: search, survey, and salvage. A search area of approximately three by five kilometres (1.6 by 2.7 miles) was scanned using high resolution side-scan sonar equipment. The search consisted of running 200 metre search swaths using microwave positioning equipment. The aircraft was located and the position fixed in 270 feet of water, approximately 3.7 miles southeast of the Toronto Island Airport. Positive identification of the target was confirmed visually by deploying a "DART" remote operated vehicle (ROV) equipped with a video camera to examine the aircraft on the lake bottom.

Survey of the aircraft exterior, cockpit, and bottom material was then undertaken to obtain preliminary investigative information and, at the same time, assess the aircraft's condition to evaluate salvage options. A specially equipped ROV was used for these tasks.

From study of the videotapes and engineering drawings of the aircraft, a method of salvage was developed. A barge equipped with a long-reach, heavy-lift crane outfitted with a winch and sufficient cable length to reach the lake bottom was positioned and anchored directly above the aircraft. It was moored to concrete blocks, lowered from the water surface.

A fork assembly was built to fit under the wings of the aircraft so that the crane could lift the aircraft vertically to the surface in a horizontal attitude. Because of the varying current and poor visibility

(often less than three feet with high intensity floodlight illumination), an accurate, mobile underwater guidance system was constructed to provide a means through which the fork assembly could be mated to the aircraft by remote control from the surface.

A video camera aiming system, approach and aiming lights, variable speed thrusters, transit sonar, an underwater acoustic location system with beacons, and the brightly pattern-painted fork assembly were used as an integrated package. The forks were guided to, then under the wings of the aircraft, and the aircraft was raised to a depth of 20 feet below the surface where police divers then attached safety lines and underwater homing beacons on it prior to lifting it from the water and placing it on the barge.

2.0 ANALYSIS

2.1 Introduction

While on a VFR flight from St. Catharines to Toronto Island Airport, the aircraft lost power to both engines and ditched in Lake Ontario, about 3.5 miles south-southeast of the Toronto Island Airport. Both occupants were rescued, but the pilot later died from hypothermia.

The investigation centred on the fuel state of the aircraft, the aircraft fuel system, the aircraft and its serviceability, the weather conditions, and the subsequent search and rescue activities.

2.2 The Flight

On 12 January 1986, following a 10- to 15-minute run-up, the aircraft departed from the Toronto Island Airport in a routine manner, climbed to 1,500 feet, and flew direct to the St. Catharines Airport. This leg of the flight was uneventful and took 18 minutes to complete. The aircraft landed on runway 24 at the St. Catharines Airport.

Following a 13-minute stopover in St. Catharines, the aircraft engines were started, and, at the request of the pilot, the aircraft departed runway 24 from the intersection of Taxiway Bravo without an engine run-up. This would indicate the aircraft engines were operating normally at that time. The aircraft was not refuelled at St. Catharines; however, the passenger stated the pilot told him that he would obtain fuel at Toronto Island before proceeding on to Oshawa, 28 nautical miles east of Toronto Island.

The passenger reported that the flight levelled off at 1,500 feet and was proceeding direct to Toronto Island without difficulty, when approximately half-way across the lake and without warning, the left engine stopped, and the pilot was unsuccessful in restoring power to the engine. The propeller continued to rotate at approximately 1500 rpm with the engine manifold pressure reading 28 or 29 inches, and a fuel pressure indication of zero. These engine instrument readings are indicative of a windmilling propeller and an interruption of the fuel supply. Power was increased on the right engine, and the aircraft maintained altitude for two to three minutes, until the right

engine began to malfunction in a manner similar to the left engine, and then stopped. The fuel pressure reading was not noted.

Prior to the right engine stopping, the pilot had obtained landing instructions from the Toronto Island Tower but had not advised the tower he was operating on one engine. It was not until the second engine began to malfunction and the aircraft began to lose altitude that the pilot reported he was experiencing difficulty.

Because the propeller levers were found in the feather position, the pilot must have feathered the propellers after the right engine had stopped and prior to or upon ditching the aircraft. The reason the propellers were in an unfeathered position when the aircraft was recovered is either because, when the feather position was selected, the propellers had already stopped rotating or because the propeller rpm had slowed sufficiently for the anti-feathering pins to prevent the propellers from feathering.

2.3 Fuel State of the Aircraft

Three of the five flights since the last refuelling of the aircraft were training flights conducted at various altitudes and flight configurations, which made calculating of the total fuel consumed during these flights difficult. Calculations were performed using the engine manufacturer's predicted fuel consumption rate for cruise flight at 65 per cent. However, the fuel consumption rate used assumed a steady cruise power setting and a leaned fuel/air mixture. During the training flights, the power settings would have been higher than cruise power and the mixture, in all probability, not leaned, thus the fuel consumption would have been higher than the calculated amount. Furthermore, the flights on 12 January were at low altitude, thus it is unlikely any leaning took place which would again result in higher rates of consumption than the calculations indicate. Also, it was not possible to compute the fuel consumed for the various start-ups, taxis, run-ups, take-offs, and climbs. Hence, the total fuel consumed was significantly in excess of the amount calculated for the flight at cruise power settings.

2.4 Aircraft Fuel System

The aircraft fuel system does not have any fuel component common to both engines. Therefore, under normal operation, to have both engines stop because of a component failure, two components, one in each system, would have to fail within minutes of each other. There was no evidence of component failure found during the examination of the aircraft, nor was there any blockage found in the fuel lines or fuel filters that would have prevented the flow of fuel to the engines with the fuel selectors in either the ON or CROSS-FEED position.

The fuel tank sumps ruptured when the fuel tank bottoms collapsed inward because of the pressure exerted on them when the aircraft sank to the bottom of the lake in deep water. Any liquid content in the fuel tanks and fuel lines to the fuel gascolator bowls was lost through the ruptured sumps, when the aircraft was raised from the water.

The left engine fuel selector was found in the CROSS-FEED position, which indicates that the pilot was attempting to supply the left engine with fuel from the right fuel tank at some time during the flight from St. Catharines, most likely after the left engine stopped and he suspected fuel starvation from the left fuel tank. The lack of fluid, either fuel or water, present in the fuel lines to both engines indicates the presence of air in the lines prior to the aircraft sinking. Air would enter the fuel lines if the supply of fuel was interrupted or if the usable fuel was exhausted from the fuel tanks, while the aircraft was in flight. In this instance, it was concluded that the usable fuel was exhausted from both fuel tanks in flight, and the aircraft engines stopped.

Fuel exhaustion is supported by the observed lack of fuel pressure when the left engine stopped and by the critically low fuel quantity as indicated by the above analysis.

2.5 Pre-Flight Preparation

It could not be determined how the pilot calculated the amount of fuel on board prior to departure from Toronto Island Airport. The aircraft Journey Log Book was not carried on board the flight but was located at the company office at Toronto Island Airport. It is not known if the pilot referred to the log book to calculate the fuel on board the aircraft or to determine when it was last fuelled. A fuel dipstick

was on board the aircraft, but it could not be determined if the pilot had used the dipstick to measure fuel in the tanks. The aircraft fuel gauges were reported to be serviceable; however, their accuracy in indicating fuel contents at the low end of the scale was considered questionable as are most fuel gauges in light- to medium-weight aircraft. It is apparent from fuel computations and the fuel gauge reading following the ground run on 09 January 1987 that the quantity of fuel on board on departure from St. Catharines was not sufficient to carry out the flight to Toronto Island with a 45-minute reserve of fuel required by regulations for VFR flight. Fuelling receipts for the aircraft show that, on two previous and separate flights, the pilot flew the aircraft with considerably less fuel on board than the required 45-minute reserve.

It is the pilot's responsibility to ensure sufficient fuel is carried to complete the trip with adequate reserves. There was evidence presented at the Board's public inquiry that the pilot was capable and safety conscious. Various factors, such as pilot background and training and possible company pressure because of scheduling or economic reasons, which may have influenced the pilot's decision-making were investigated. This investigation could find no conclusive evidence to show why the pilot undertook this flight with insufficient fuel.

2.6 Incorrect Placarding of Induction Heat Levers

During the investigation, it was discovered that the induction heat levers in the occurrence aircraft and other Britten-Norman Islanders were placarded as CARB HEAT levers in spite of the fact that the engines were fuel-injected models.

2.7 Weather

Ceiling and visibility conditions in the St. Catharines and Toronto Island Control Zones, throughout the entire time of the flight, remained above VFR flight minima and would not have presented any weather difficulties for the pilot. The flight was conducted in VFR conditions, which precluded the possibility of the flight encountering any icing conditions that would have adversely affected the engine induction system. The brief snow shower which passed through the search area hampered the initial portion of the search, when C-GTAX was forced to land on shore briefly as the shower passed through.

2.8 Accident Response (Search Phase)

The accident response was initially commenced by the Toronto Island Control Tower personnel, as they were the agency in communication with Trillium Flight 123 at the time of the occurrence.

Because no flight plan or itinerary had been filed, it was fortunate that air traffic services personnel both at Toronto Island and St. Catharines were familiar with Trillium Air personnel and company operations. They were the sole source of important initial information about the flight when the aircraft ditched in the lake and rescue attempts were getting underway. However, even with knowledge of the aircraft and the company, ATC would have to consider that they might have to arrange for the rescue of up to 10 people when there was no flight plan information on the number on board the aircraft. They responded first by alerting the airport CFR and the Toronto/Lester B. Pearson departure radar controller for possible radar contact and by clearing all other traffic from the runways when the pilot stated the aircraft engines were malfunctioning and he intended to land at the airport. Radar contact with the flight could not be established, probably because the aircraft was at too low an altitude when the departure controller was attempting to contact it.

When it became obvious that the aircraft was going to ditch in the lake, the tower commenced notification in accordance with the Toronto Island Tower written response instructions for off-airport water crashes and, in addition, solicited the assistance of a local commercial helicopter operator and directed the Cessna 152 aircraft that volunteered assistance, to the last position the Trillium 123 pilot gave. Prior to the helicopter pilots' organizing themselves on a separate frequency, the control tower was the sole communication link with the various agencies that responded. Because the police boat was unable to communicate with the circling aircraft or Toronto Island Tower, coordination of the search was difficult. Direct VHF communication with the boat would have lessened the tower workload at a busy time and facilitated accurate instructions about the accident area.

2.9 Accident Response (Rescue Phase)

Upon locating the survivors in the water, the helicopter crews were faced with the decision of which one to try and assist. The pilot was motionless in the water, while the passenger was waving his arms. The helicopters were not specialized rescue helicopters and

lacked the equipment and personnel to hoist the victims out of the water. Therefore, in order to attempt any kind of rescue, the helicopter crews had no choice but to attempt to help the passenger who appeared to be capable of assisting in his rescue in the water.

The police marine boat was some distance away from the location of the survivors and could not communicate directly with the helicopter. The Aerospatiale Astar (C-GATX) helicopter pilot's attempt to rescue the passenger was unsuccessful, and he moved away when the air ambulance helicopter BK117 (C-GIRB) arrived. Because the BK117 tail rotor had greater clearance from the water than the tail rotor of the Astar helicopter, the BK117 was able to descend lower to effect the rescue. The air ambulance attendant was able to grab hold of the passenger and wrap his arm around the skid, while the pilot hovered the helicopter inches above the water surface. The attendant held onto the passenger while the helicopter air taxied to shore. The Metro Marine Unit then arrived and pulled the pilot into the boat and began treatment on him. There was insufficient time for the crew of the police helicopter to attach the Billy Pugh style net to the helicopter hoisting mechanism and return to the site to assist in the rescue of the survivors from the water.

Had there been direct communications available between the helicopters and the police boat, the helicopters could have readily directed the police boat to the area where the victims were in the water. This would have allowed the police boat to pick up both victims and not involved the helicopters in the attempted rescue by the Ranger Lake helicopter and the rescue by the Ministry of Health helicopter. This placed the helicopter crews in a hazardous situation in that they were required to hover within inches of the rough water surface, a manoeuvre for which neither crew was trained or equipped.

The RCC's response in tasking the Labrador helicopter and, subsequently, the Buffalo aircraft was carried out in accordance with their mandate, and both aircraft were airborne within the 30-minute response time required; however, RCC was not notified until 12 minutes after the accident. In this case, Toronto Area Control Centre did not coordinate the required notification when informed of the ditching by Toronto Island Tower.

2.10 CFR Services at Toronto Island Airport

While it would not have influenced the outcome of the accident, it was noted during the investigation that the CFR services provided at the airport are at a Category II level and not at a Category V level. At the time of the accident, Transport Canada did not require non-Transport Canada airports to provide CFR services to the same standard as Transport Canada owned and operated airports. Although the responsibility for operating into an airport where CFR services do not meet the level required is that of the aircraft operator, Transport Canada does not ensure that these airports have the standard level of CFR services.

2.11 Accident Site Location

Toronto Island Tower does not have any capability, such as DF or radar equipment, of determining location of aircraft other than by visual sighting. Visual contact with Trillium Flight 123 was not established prior to the aircraft ditching.

During the initial phase of the emergency, the Toronto Island controller requested the assistance of the Toronto/Lester B. Pearson International Airport departure controller to identify Flight 123 on radar. However, radar contact was not established, probably because the aircraft was too low for radar detection.

2.12 Water Rescue Capabilities

Response to an occurrence which involves water rescue in and around the Toronto area is dependent upon a number of climatic variables. In this accident, police of the Metro Marine Unit were able to respond, and their boat was underway within one minute from the time that the Unit was notified. The boat was not adversely affected by the four-to six-foot waves that were reported on Lake Ontario. At the time, there was no ice in the harbour which, if present, would have prevented the police boat from being dispatched. Had the police boat not been able to respond, there were no other rescue platforms available that could have provided rapid response to rescue persons from the water. At the time of the accident, there were no rescue helicopters or hovercraft based in the Toronto area that could have provided rapid response had there been ice in the Toronto harbour area. As well, in the Toronto harbour front area, there were no dedicated resources, such as life-rafts, available for immediate

transport to the scene of a water rescue. In winter, a quick response is necessary because of the limited survival time in the near freezing water.

The RCC in Trenton, Ontario, by tasking a SAR aircraft, can provide a water rescue capability, with the response time dependent on the distance from the search area. The aircraft is capable of dropping life-rafts and para-rescue personnel if required to assist in a water rescue.

Because it was winter, the Canadian Coast Guard did not have any boats in the water that could have provided rapid response to the accident. A vessel (SAR 1), which is a Zodiac-type boat based at Pickering, Ontario and stored inside, was dispatched to provide assistance but did not arrive in time to participate in the rescue.

If this accident had occurred in the summer, there probably would have been many more resources available to provide rapid response. The Canadian Coast Guard at its Marine Rescue Auxiliary Squadron, located in the Toronto area, would have been able to provide assistance. Also, the accident was in an area which is used quite extensively by pleasure boaters who could have rendered assistance.

2.13 Medical Findings

The pilot was in good health as evidenced by his Transport Canada Category I medical status. He appeared to be fit and well motivated towards flying. There was no evidence to suggest that he was suffering from any personal problems that may have affected his ability to perform his assigned duties at Trillium Air.

2.13.1 Pathological Findings

There were no signs that the occupants were injured at the time of impact, thus indicating that the landing was cushioned sufficiently to prevent any impact-type injuries. It was determined that the pilot was pulled from the water in an unconscious state and that the cause of death was hypothermia. Because the life-jacket the pilot was wearing was able to keep his head in an upright position, there was no inhalation of water that would have led to drowning.

2.13.2 Toxicological Findings

Independent tests confirmed the presence of small amounts of drugs in the blood sample. On the basis of expert testimony at the public inquiry and subsequent analysis, the Board concluded that these small amounts were not a contributing factor in this accident.

2.14 Survival Aspects

Although life-jackets were not required by regulation to be carried on this flight, it is highly probable that, without them on board the aircraft, neither person would have survived this accident, nor would they have been able to remain afloat for the period of time they were in the water. The life-jackets, manufactured in accordance with Technical Standard Order (TSO) C-13d, performed as per the specifications and, in particular, kept the head of the unconscious pilot out of the water which probably prevented him from drowning. Other than a small light, which was required by regulation, there were no other signalling devices attached to this life-jacket, nor were any required by regulation.

During the search phase of this accident, a lengthy time delay was incurred trying to locate the persons in the water after visual contact with them was lost. When the aircraft sank, it was extremely difficult, given the existing water conditions, to spot two persons floating in the water. Had there been a signalling device available to the survivors, rescue might have been accomplished sooner.

The ELT switch was found in the OFF position rather than in the required ARMED position. Although the forces during ditching were not sufficient to activate the ELT, it is good airmanship to fly with the ELT armed so that the signal is automatically turned on during an impact, thus facilitating search and rescue.

The pilot did not advise any agency of his difficulties until the second engine stopped and the aircraft was at low altitude. Had he advised an air traffic control agency when the first engine stopped or while the aircraft was at a higher altitude, radar contact might have been established which might have aided in the rescue. Also rescue agencies could have been alerted before the aircraft actually went down.

2.15 Toronto Island Airport Disaster/Emergency Plan

In February 1986, Transport Canada required Toronto Island Airport to develop emergency plans which included crashes on and off the airport. Since Toronto Island borders on Lake Ontario, this plan also had to provide for accidents that occur in the water. Prior to this, Toronto Island held a class designator which did not require an airport disaster/emergency plan. However, upon re-designation of the airport, preparation of such a plan commenced. On 12 January 1987, the plan was in draft form and not officially implemented, although airport personnel were aware of the plan.

3.0 CONCLUSIONS

3.1 Findings

1. The aircraft engines stopped when the usable fuel was exhausted from the aircraft fuel tanks.

2. The pilot successfully ditched the aircraft; it sank seven to eight minutes after ditching.

3. The occupants evacuated the aircraft wearing life-preservers; visual contact with them was lost after the aircraft sank.

4. There was no direct communication between Toronto Island Tower and the police marine unit vessel, nor between local aircraft and the vessel; this made coordination of the search and rescue more difficult.

5. Toronto Island, a non-Transport Canada airport, was not required to provide the appropriate level of CFR services.

6. Toronto Island Tower did not have the equipment to assist in locating the aircraft.

7. There were no dedicated resources, such as life-rafts, readily available in the Toronto harbour area that could be quickly transported to a water rescue site.

8. Although not required to be on board by regulation, the life-jacket was instrumental in preventing the passenger from drowning.

9. The Area Control Centre did not inform the Rescue Coordination Centre upon notification of the accident as is required by MANOPS.

10. The Rescue Coordination Centre was not notified until 12 minutes after the accident.

11. Rescue capability in the Toronto harbour area is limited when the harbour is icebound.

12. No flight plan, flight notification, or flight itinerary had been filed with any agency or responsible person as required by good airmanship and also required by regulation.

13. The induction heat levers were incorrectly placarded CARB HEAT.

14. The pilot flew the aircraft on the accident flight and on two previous flights with less fuel on board than the required 45-minute reserve.

15. The aircraft was flown with the ELT in the OFF position rather than in the required ARMED position.

16. The pilot was certified and qualified for the flight in accordance with existing regulations.

17. The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

18. There was no evidence found of any airframe failure or system malfunction prior to or during the flight.

19. The weight and centre of gravity were within the prescribed limits.

3.2 Causes

The pilot undertook the flight with insufficient fuel. The rescue was delayed because rescue agencies had difficulty locating the aircraft occupants on the rough water surface and also because the survivors did not have effective signalling devices available while awaiting rescue in the water.

4.0 SAFETY ACTION

4.1 Action Taken

4.1.1 In February 1986, Toronto Island Airport was classified in an airport category that required the development of an Airport Disaster/Emergency Plan detailing procedures for crashes on and off the airport. As of the date of the Trillium Air accident, a draft plan had been prepared but had not been officially approved by Transport Canada. Subsequently, an Airport Disaster/Emergency Plan was approved and implemented on 10 April 1987. Procedures for coping with a crash into water near the Toronto Island Airport are now in effect.

4.1.2 In 1982, Transport Canada conducted a Water Rescue Capability Study for Transport Canada owned and operated airports. Among other things, this study recommended that water rescue procedures be included in the Airport Emergency Planning Manual, AK-13-01-002. It is understood that Transport Canada intends to amend this manual to include Toronto Island Airport.

4.1.3 An Aviation Safety Advisory dealing with the incorrect placarding of induction heat levers on Britten-Norman Islanders was sent to Transport Canada on 23 September 1987. Subsequently, Transport Canada advised CASB that the British Civil Aviation Authority (CAA) had been formally notified of the incorrect placard.

4.1.4 The level of Crash Firefighting and Rescue Service (CFR) at the Toronto Island Airport has been increased to level 5, commensurate with the current level of operations at Toronto Island Airport. To meet this standard, Transport Canada provided Toronto Island Airport with a larger firefighting vehicle as part of a subsidization program. The Canada Flight Supplement (effective 0901Z 14 January 1988) was amended to reflect this increased level of service.

4.2 Action Required

4.2.1 VHF Communication for Toronto Metropolitan Police Marine Vessels

After the ditched aircraft sank, the search for the two survivors became increasingly difficult. Even though they wore bright yellow life-jackets, they could not be spotted in the breaking three- to four-foot waves that surrounded them. The pilot of the Cessna 152, who originally spotted the two survivors on the wing of the

ditched aircraft, soon lost sight of them when the floating aircraft was no longer available as a visual reference. The Metropolitan Toronto Police Marine Unit vessel spotted the Cessna 152 circling over the ditching site and proceeded towards it. Unfortunately, this vessel was unable to communicate with the circling aircraft or Toronto Island Tower. All messages had to be relayed through land-lines to the Marine Dispatch on shore, then onward to the rescue vessel. This lack of direct communication hampered the initial search and rescue attempts by the Marine Unit. Therefore, the CASB recommends that:

> The Department of Transport officials liaise with the appropriate provincial authorities to ensure that the Metropolitan Toronto Police Marine Unit vessels are equipped with VHF AM communications to permit direct communication with overflying aircraft.

CASB 88-19

4.2.2 Location of Downed Aircraft at Toronto Island

Direction Finding (DF) equipment allows air traffic controllers to determine an aircraft's bearing from the control facility when that aircraft makes a transmission. Thus, it is used to provide directional assistance to VFR aircraft during times of navigational difficulty. DF is not a substitute for radar, but it can help in the location of aircraft below 1,500 feet agl, which produce a weak radar return or which are not transponder-equipped. Toronto Island Tower does not have DF equipment installed. Thus, given the lack of radar coverage, accurate bearings to the ditching site and to the Cessna 152 overhead the ditching site were not possible. In view of the current traffic levels at Toronto Island and the inability of the Toronto Island Tower to establish an accurate location of an aircraft in distress, the CASB recommends that:

> The Department of Transport install suitable equipment at Toronto Island Airport to better monitor and assist in the location of downed VFR aircraft.

CASB 88-20

4.2.3 Life-Jackets - Mandatory Carriage

Current legislation (ANO Series II No. 8) does not require the carriage of life-jackets on multi-engined aircraft flying within 50 nautical miles of land, if they can maintain flight on one engine, such as the accident aircraft. The apparent rationale is that the

single-engine performance of such aircraft should permit the aircraft to reach land-fall safely in the event of engine failure. Nevertheless, Trillium Air had provided 10 life-jackets for passengers and crew because the aircraft was extensively used on over-water flights between Toronto Island and St. Catharines. These life-jackets were instrumental in the subsequent search and recovery of the men from the frigid waters of Lake Ontario.

Since 1980, there have been 29 ditchings in Canada within 50 nautical miles of land, of which seven were due to fuel starvation. Four of these 29 ditchings involved multi-engined aircraft, two because of fuel starvation and two because of fuel contamination. The single-engine performance of twin-engined aircraft is not a relevant criterion when fuel exhaustion, starvation, or contamination causes the loss of both engines. Moreover, where aircraft spend a considerable amount of time operating over or near large bodies of water, they are at higher risk to ditching should a forced landing become necessary. Indeed, in some cases, a ditching is preferable to a forced landing on difficult terrain. The Board believes that the lack of a mandatory requirement to carry life-jackets on board commercial aircraft operating under conditions similar to those of Trillium 123 constitutes an unnecessary risk to passengers and crew in the event of a ditching.

Therefore, the CASB recommends that:

> The Department of Transport require the carriage of effective personal flotation devices on commercial aircraft that regularly fly over or near significant bodies of open water, including those aircraft whose arrival or departure paths are over open bodies of water.

CASB 88-21

4.2.4 Life-Jackets - Signalling Devices

In spite of the bright yellow life-jackets worn by the survivors, lack of appropriate signalling devices delayed the search and rescue attempt. The life-jackets were manufactured in accordance with Technical Standard Order (TSO) C-13C and contained a small light which was inadequate for daylight signalling. If some other means to signal, such as strobe lights, smoke or dye had been available in the life-jackets, then a much earlier rescue may have been accomplished.

Therefore, to facilitate the timely location of survivors in all weather conditions, the CASB recommends that:

> The Department of Transport require improved signalling devices on all life-jackets certified for carriage on aircraft.

CASB 88-22

4.2.5 Air Disasters in Water near Airports

Different marine operators in and around Toronto Harbour and along the Lake Ontario waterfront carry only limited life-saving equipment unique to their operations. In the event that a large commercial aircraft were to ditch in the Toronto Harbour area, a successful rescue of all potential survivors would be unlikely. Presently, there is no agency designated to organize a major rescue from these waters. Such an agency would have to consider many factors such as equipment, storage, infrastructure, command and control and funding.

Toronto Island Airport has a Disaster/Emergency Plan for smaller aircraft that might ditch in the immediate vicinity of the airport. However, this plan is not adequate for an air disaster in the Toronto Harbour area. While the Disaster/Emergency plan for Lester B. Pearson International deals with crash response on and off the airport, it also does not address response to a ditching of a large aircraft in Lake Ontario. Transport Canada has identified many airports across Canada that are located on or near large bodies of water. These airports require Disaster/Emergency Plans that include provisions for an aircraft that inadvertently lands in the water necessitating passenger rescue. There may be other airports identified in AK 13-01-002 (TP 1801) which ,like Toronto's Lester B. Pearson International, lack water rescue contingency plans.

Therefore, the CASB recommends that:

> The Department of Transport ensure that Airport Disaster/Emergency Plans for airports on or near large bodies of water include provisions for response to an air disaster in the water.

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4.3 Safety Concerns

4.3.1 Inadequate Cockpit Indications of a Fuel Low-Level State

The Board is concerned about the number of fuel exhaustion and fuel starvation accidents. The causes of these accidents vary from inadequately designed fuel gauges to inadequate flight planning and in-flight fuel monitoring procedures. The Board believes many of these accidents could have been prevented if all aircraft were equipped with an independent low-level fuel sensor warning system. The Board is continuing to monitor occurrences stemming from fuel exhaustion and further recommendations may be forthcoming.

This report and the safety action therein has been adopted by the Chairman, K.J. Thorneycroft, and Board Members:

W. MacEachern
D. Mussallem
A. Portelance
F. Thurston

N. Bobbitt (Abstained)

Members L. Filotas and R. Stevenson dissented as follows:

In our opinion, the statement that the pilot undertook the flight with insufficient fuel is not a cause but a consequence. To determine the underlying cause, the investigation would have had to delve more deeply into the human factors that induced such a "capable and safety-conscious" pilot to undertake a flight over open water with less than 20 minutes of usable fuel.

We agree that there was no "conclusive evidence" of overt pressure to undertake the flight with inadequate fuel reserves. But, based on credible witnesses' evidence, we conclude that the pilot believed that his job would be jeopardized if he did not run the tanks nearly dry when the aircraft was to be left for long-term storage after a short flight.

While the company's operating practices met the strict letter of applicable regulations, pilots believed that management expected them to operate to minimum standards in order to cut costs. Absences of the part-time Chief Engineer led, for example, to flights with deferred maintenance items that created the impression that safety margins could be compromised by economic considerations.

Accordingly, we would propose the following additional findings:

- Company management did not take effective steps to ensure that all flights carried adequate fuel reserves as required by Transport Canada regulations.

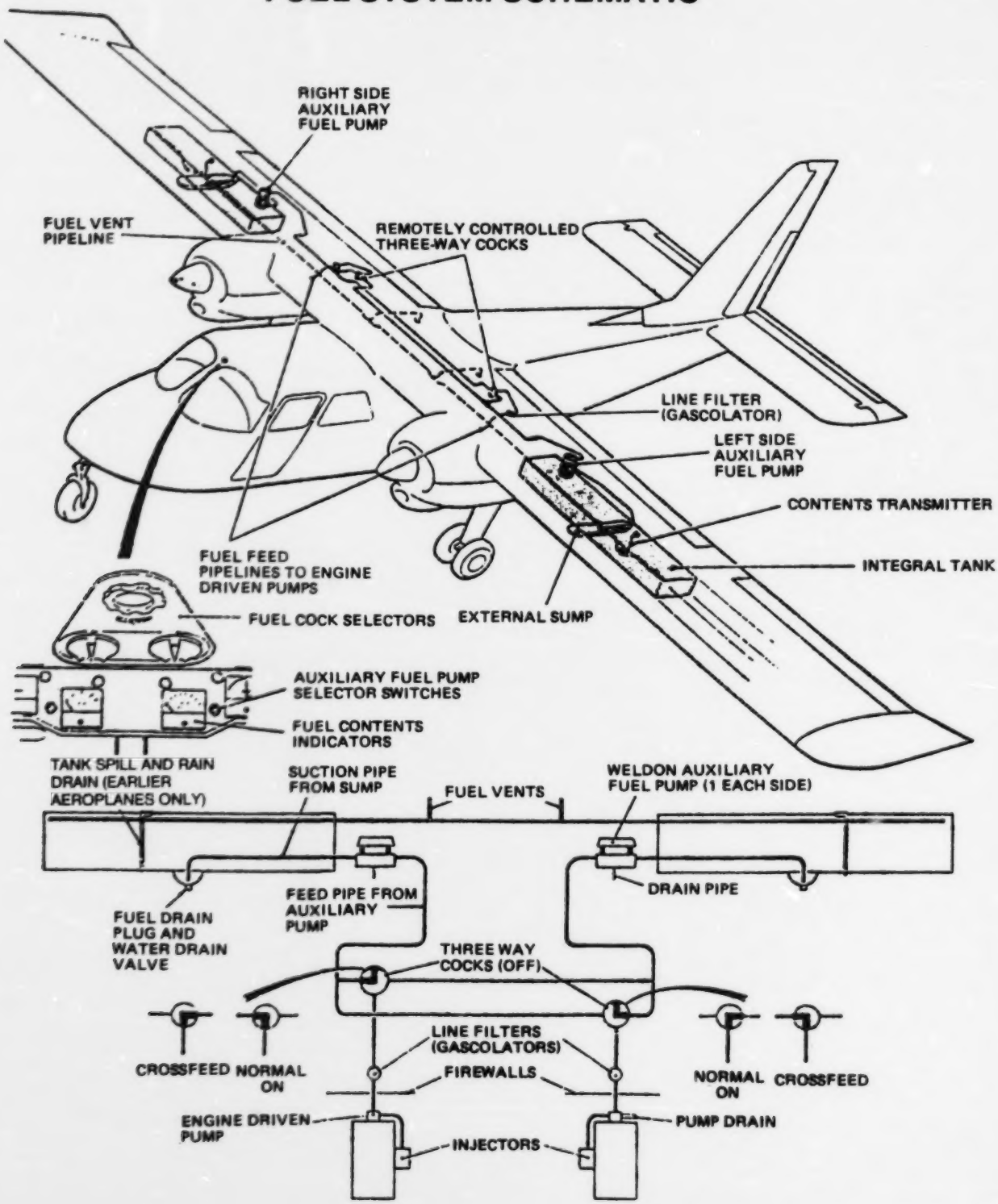
- Transport Canada's surveillance and audit procedures allowed safety margins to be eroded in the operation of this company.

ACCIDENT SITE DIAGRAM

LEGEND

1 – Survivors picked up.
2 – Radar fix.
3 – Marker buoy.
4 – Metro Police marine base.
5 – Cherry Beach Heliport.
6 – Sick Children Hospital (Heliport).
7 – Sunnybrook Medical Centre (Heliport).

FUEL SYSTEM SCHEMATIC



APPENDIX C

SEQUENCE OF EVENTS

TIME(EST)	EVENT
1102:54	Initial call from Trillium 123 to Toronto Island Tower requesting landing instructions for runway 08.
1103:54	Trillium 123 transmits urgent (Pan) message requesting landing on runway 03.
1104:34	Trillium 123 states aircraft engine malfunctioning because of carburettor ice and requests a straight-in approach to runway 33.
1105:34	Toronto Island Tower advises Trillium 123 cleared to land on any runway. Trillium 123 advises he might not make it to the runway.
1105:36	Toronto Island Tower requests airport CFR equipment to stand by. CFR responds and proceeds to the threshold of runway 33.
1106:03	Trillium 123 reports he is about one mile south. Toronto Island Tower contacts the departure controller at Toronto/Lester B. Pearson to attempt radar contact with Trillium 123. Departure controller reports no radar contact in the area south of Toronto Island.
1106:20	Trillium 123 declares a MAYDAY and intention to ditch in the lake and that he is 50 feet above the water three quarters of a mile out.
1106:27	Toronto Island Tower attempts to contact Toronto Metro Marine Unit on direct line; no answer by 1107:14.
1107:35	Trillium 123 advises he is floating on the lake.
1107:51	Toronto Island Tower contacts emergency 911 number and advises them that an aircraft has landed in Lake Ontario, could they notify the Metro Police Marine Unit; 911 operator advises they will do that and get an ambulance on the way.

1108:08	Cessna 152, C-GYJK, cleared for take-off runway 26 - left turn out to attempt to locate Trillium 123.
1108:56	Island Tower directs CFR to the south shore of the Island.
1109:14	Island Tower contacts Metro Police Marine Unit and advises them that the aircraft is down in the lake three quarters of a mile out from runway 33.
1110:26	Island Tower contacts Toronto Island Police and advises them that the aircraft is down in the lake and that the CFR unit is going to the south shore - could they assist?
1110:40	Toronto Area Control Centre contacts Toronto Island Tower and obtains information about Trillium 123 in the lake.
1112:00	Metro Marine Unit boat dispatched to accident site.
1113:11	Toronto Island Tower requests special weather observation from weather office.
1113:21	Toronto Island Tower calls Ranger Helicopters and explains to person on the phone that an aircraft has gone down in the lake south of the airport, could they deviate a little south with their flight to have a look for it? The receptionist passes the message to the dispatcher. A pilot with Ranger Helicopters overheard the conversation about an aircraft down in the lake and told the dispatcher to call Island Tower to see if they could help with a helicopter. The phone line appears to disconnect at 1114:17.
1113:35	Cessna 152 locates Trillium 123 floating on the lake with the wings and tail visible and people on the wing, approximately two miles south of, and about one mile to the east of, the approach to runway 33. Island Tower advises the 152 to keep circling over the aircraft and that a boat is on the way out.
1113:57	Toronto Terminal Supervisor calls St. Catharines Tower and gets information about Trillium 123 - ascertains that two people were on board.

1114:43 Toronto Centre Supervisor advised the Canadian Aviation Safety Board, Ontario Regional Office in Toronto of the accident.

1114:49 Island Tower advises the Toronto Area Control Centre that the Cessna 152 has located Trillium 123 in the water.

1115:00 Cessna 152 advises Toronto Island Tower that the aircraft is underwater and two people with life-preservers on are in the water.

1115:08 Island Tower advises the Cessna 152 that the boat is just south of the approach to runway 08.

1115:22 Island Tower advises Metro Police Marine Unit that an aircraft is circling over the location of Trillium 123 and could they pass that information on to the boat.

1116:07 Toronto Terminal Coordinator contacts Toronto Buttonville Tower to request assistance from air ambulance helicopter.

1116:10 Cessna 152 advises Island Tower that he has lost sight of the people in the water and that he will circle and continue to look.

1116:46 Toronto Island Tower asks if there are any helicopters on the frequency. The Ranger Helicopters pilot hears this transmission on the company VHF monitor and proceeds to helicopter C-GATX with two observers.

1116:49 Ranger Helicopters dispatcher calls Island Tower and asks if they need a helicopter - Ranger can have one there in about three minutes. Tower advises they can use a helicopter.

1117:22 Metro Marine Police Unit calls Island Tower to ask them to keep the aircraft circling over the aircraft in the water. Island Tower advises them the aircraft will continue to circle.

1117:50 Buttonville Tower advised Toronto Centre that air ambulance helicopter could fly if the crew received authority from Ministry of Health Supervisor and that the crew was on stand by.

1118:00 Metro Police Marine Unit notifies Trenton Search and Rescue of an aircraft crash in Lake Ontario, two miles south of Toronto Island.

1118:00 Buttonville advised the Toronto Terminal Coordinator that the ambulance helicopter was going to depart. Helicopter crew had to go to a hangar and get the helicopter (C-GIRB).

1118:02 Toronto Island Tower asks Toronto International Tower if there are any of Ranger's helicopters heading towards the Island. Toronto International's reply was negative.

1118:09 Island Tower advises Cessna 152 that the police boat is just crossing Gibraltar Point.

1118:30 Toronto Island Tower contacts a fixed-based operator for Trillium Air to see if they can get any information as to how many persons are on board Trillium 123.

1118:50 Toronto Area Control Centre called Island Tower for update and advised Island Tower there was two crew on board. Also stated air ambulance helicopter was going to depart from Buttonville for the Island. Island Tower advises helicopter not needed aircraft circling and boat on the way.

1119:20 Island Tower advises Cessna 152 there were two persons on board Trillium 123 - Cessna 152 states he does not have people in sight and is continuing to circle.

1119:35 Toronto Terminal Supervisor advised Buttonville Tower that air ambulance not needed. Buttonville advises they would cancel the helicopter and this was done at 1120:00.

1119:58 Toronto Island Tower called Metro Police and told them there were two people on board the downed plane and that a plane was still circling above the site.

1120:13 Helicopter C-GATX on the Island Tower frequency and was advised Cessna 152 circling the area where downed plane was last seen in the water. Cessna 152 was advised that the helicopter was proceeding to the area where he was circling.

1121:41 Helicopter C-GATX advises Island Tower Cessna 152 in sight. Cessna 152 advises he is over the spot where he last saw the people. Helicopter C-GATX proceeds to that area.

1121:49 Eagle Repair calls Island Tower back with information on Trillium 123.

1122:00 Labrador helicopter (Rescue 308) tasked by Trenton Rescue Coordination Centre (RCC).

1122:29 Helicopter C-GATX and Cessna 152 have each other in sight and are communicating with each other on tower frequency. The helicopter suggests that the 152 climb up a little higher and the helicopter will stay low.

1122:40 Island Tower calls Metro Marine Police to advise them of a helicopter in the area with the circling aircraft. Marine Police advises the boat has the helicopter and circling aircraft in sight and is about one mile from them.

1122:53 Toronto departure controller advises Island Tower that the helicopter is two or three miles too far south. Island Tower advises the Cessna 152 is there and the helicopter is talking with him on the frequency.

1123:10 Ministry of Health contacts the Island Tower about sending air ambulance helicopter to the Island. Decision was made to send helicopter; (1125:01) helicopter crew was advised to go again.

1124:24 Cessna 152 indicates to the helicopter the spot where he last observed the aircraft and people by stating he is right over the spot at this time. The helicopter remains in the area under the Cessna 152 while the 152 climbs up to 1,500 feet. No sight of aircraft or persons in the water.

1126:04	Helicopter C-GATX has police boat in sight about one-half mile away.
1126:25	Toronto Tower advises Island Tower that Ontario Provincial Police (OPP) helicopter is standing by. OPP helicopter was requested by Metro Marine Police.
1126:55	Trenton RCC contacts Island Tower for information about Trillium 123.
1128:00	Trenton RCC tasks a Buffalo aircraft (Rescue 464).
1128:28	Helicopter C-GATX advises Island Tower that the boat is on the accident site.
1129:11	As requested by the Toronto departure controller, the Toronto Island Tower instructs the helicopter to squawk transponder code 7700 to mark the radar fix.
1130:00	OPP advised Metro Marine Police that OPP helicopter is on its way.
1130:27	The Island Tower advises the Cessna 152 that the Metro Marine Police are asking if their boat is on the exact position where the aircraft was last seen in the water. The Cessna 152 advises that the boat should move about one-half mile east. This information is passed to the police at 1131:21.
1131:35	Trenton RCC contacts the Island Tower for more information about Trillium 123.
1132:35	After losing sight of each other, the helicopter and Cessna 152 locate each other and are both over the locale where the Cessna 152 believes the aircraft sank. This information was passed to the Metro Marine Police. The helicopter remained hovering in the area and the Cessna 152 returned to the Island airport.
1133:58	Helicopter C-GATX advises Island Tower that the Marine Police Boat is on location right beneath him at this time.
1135:00	Rescue 308, the Labrador rescue helicopter, departs Trenton Aerodrome en route to Toronto Island.

1135:50 Helicopter C-GATX advises Island Tower that the boat is putting out an anchor. The police boat at this time was anchoring a marker at lat 43°34'29"N, long 79°18'58"W.

1137:26 Helicopter C-GATX advises the Island Tower that he is going to climb up to 1,000 feet and search downwind of his position.

1138:00 The Ministry of Health Air Ambulance helicopter, IRB, departs Buttonville Airport for Toronto Island.

1139:52 OPP helicopter C-GOXY contacts the Island Tower advising he is over Humber Bay en route to search for the downed aircraft. The Island Tower gives C-GOXY directions to the area where the aircraft was observed in the water.

1140:43 Helicopter C-GATX advises the Island Control Tower that he will have to go into shore and land because of the approaching heavy snow shower and that the police boat is anchored at the site.

1141:13 Helicopter C-GOXY advises he will be able to stay airborne and is advised by the tower that the police boat is anchored at the site where the aircraft sank.

1143:03 Air Ambulance helicopter C-GIRB contacts the Island Tower advising them he is inbound to the search area.

1143:20 Helicopter C-GOXY reports visibility low because of a snow shower over the water and proceeds towards the Island Airport but does not have to land as expected. Helicopter C-GIRB is advised of the visibility problems but is able to proceed towards the search area.

1143:41 Trenton RCC contacts the Island Tower for information about helicopters searching in the crash site area and if persons were sighted in the water. Information passed by the Island Tower.

1144:55 Helicopter C-GNPH advises Island Tower he is airborne off downtown heliport for the search area.

1145:00 Rescue 464, a Buffalo Search and Rescue aircraft, departs from Trenton en route to Toronto Island.

1145:37 Helicopter C-GATX is airborne again from the Leslie Street spit area proceeding to the search area again.

1145:46 Island Tower contacts St. Catharines Tower to confirm two people on board Trillium 123.

1146:42 With four helicopters in the area, it was decided by the helicopter pilots that they would go to a separate frequency (122.9) and organize a search on that frequency. This was accomplished and the helicopters proceeded to first locate the Marine Police boat they believed to be anchored in the area where the aircraft sank. Search was hampered by the snow shower in the area.

1149:33 President of Trillium Air calls Toronto Area Control Centre and is advised by them of the accident. The President gave Toronto ATS the name of the pilot on board.

1155:00 Helicopter C-GOXY locates Metro Marine Unit boat and believes boat is too far east. Helicopters begin searching towards the southwest.

1203:00 Helicopter C-GATX advises helicopter group that he has located two persons in the water, one person waving and the other motionless.

1203:30 Buffalo aircraft Rescue 464 contacts Island Tower advising they are just east of Toronto Island over the water. The aircraft is advised to fly towards the airport and the tower will direct them towards the accident site.

1204:52 Island Tower advises Metro Marine to contact their boat and have it proceed to where the helicopters are as they have located the people in the water.

1206:25 Island Tower advises Rescue 464 that the helicopters have located the people in the water and they are attempting to rescue them.

1208:57	Rescue 308 advises the Island Tower he is 20 miles east en route to the Island.
1210:00	Ambulance helicopter C-GIRB rescued mobile survivor and proceeds to shore with the victim on the helicopter skid.
1211:00	Rescue 464 arrives on scene.
1212:00	Metro police boat rescues second victim from the water, unconscious, and commences CPR on the victim as the boat proceeds towards shore. Persons were rescued from the water at lat 43°35'15"N, long 79°19'38"W.
1213:46	Island Tower contacts Metro Ambulance to advise that the victims have been rescued from the water. Metro Ambulance advises that there are three ambulance units at the Metro Marine Police dock.
1214:09	Helicopter C-GOXY requests the Island Tower contact the Marine Police and have them advise the Marine Unit boat to go ashore in order to transfer the victim to a helicopter.
1214:24	Helicopter C-GIRB suggests they transport the victim to Sunnybrook Hospital.
1214:38	Island Tower contacts the Metro Marine Unit to have them advise their boat to go ashore to transfer the victim to a helicopter.
1215:10	Toronto Island Tower advises air ambulance helicopter C-GIRB that ambulances are available at the Metro Marine dock.
1215:21	Helicopter C-GIRB advises the Island Tower that they are going to get the victim inside the helicopter and go directly to Sunnybrook Hospital.
1217:16	Metro Marine Police contact the Island Tower to advise that the ambulance personnel are prepared to treat the victim at their dock and that they have advised their boat to continue to the Marine dock.
1218:22	Rescue 464 advises Island Tower that Rescue 308 is with the Metro Marine boat and could hoist the victim on board the helicopter.

1219:54	Air ambulance helicopter C-GIRB advises the Island Tower that they are lifting off the shoreline and proceeding direct to Sunnybrook Hospital.
1223:13	Helicopter C-GOXY advises that the Metro Marine boat appears to be going ashore and directs Rescue 308 to a suitable location for the transfer of the victim from the boat to the Labrador helicopter.
1223:31	Rescue 464 advises the Island Tower that he has been in contact with the Metro Marine boat and it was going to shore in order to transfer the victim to the Labrador helicopter.
1226:47	Rescue 464 advises the Island Tower the rescue specialists from Rescue 308 are on board the boat attending to the victim.
1228:25	Rescue 464 advises they are transferring the victim to the Labrador helicopter by stretcher.
1230:47	Rescue 308 advises the Island Tower they are taking off and going direct to Sunnybrook Hospital.
1235:27	Rescue 308 reports on final for the helicopter pad at Sunnybrook Hospital.

APPENDIX D

PUBLIC INQUIRY WITNESSES AND PARTICIPANTS

Mr. B. M.-Deschênes, Chairman of the CASB, and the following Board Members conducted the Public Inquiry:

R. Stevenson
N. Bobbitt
L. Filotas

The following were participants at the inquiry:

The CASB technical panel: S. Musson, Chairman
F. Reinhardt, Legal Counsel
Dr. D. Elcombe, Director, Safety Medicine
C. Batchelor, Investigator
B. Mask, Investigator;

Trillium Air represented by R. Bryant, President;

Next-of-kin represented by P. Cassidy;

Pilatus Britten-Norman Ltd, absent;

Avco Lycoming Textron Williamsport Textron Inc. represented by H. Mesaris;

Toronto Harbour Commission represented by J. Thornton;

Ontario Provincial Police represented by J. Chalmers;

Metropolitan Toronto Police represented by J. Egan;

Ministry of Health of Ontario represented by M. Campbell;

Department of National Defence represented by LCol. J. Paquette;

Department of Transport represented by J. Stewart;

Chief Coroner of Ontario represented by P. Bailey;

The following testified as witnesses at the Board's public inquiry:

Steve Musson - Investigator-in-Charge, CASB;

Henry Emson - Vice-President Trillium Air, passenger on board C-GIRH.

Albert Shepherd	- Chief Engineer, Trillium Air;
Peter Sanders	- Airworthiness Specialist, Transport Canada;
Dale McCurdy	- Pilot, Trillium Air;
Robert Ernst	- Air Traffic Controller;
Malcolm Cooper	- Unit Chief Toronto Island Airport Control Tower;
John Kidston	- Shift Manager Area Control Centre, Toronto;
Daren Schapansky	- Pilot/Instructor Central Airways Toronto;
Sgt. Grant Charlesworth	- Metropolitan Toronto Police Marine Unit;
Andy Stevens	- Helicopter Pilot Ranger Helicopters Ltd.;
S/Sgt. Norm Kerr	- Helicopter Pilot, Ontario Provincial Police;
Alex Gontier	- Helicopter Pilot, Ministry of Health of Ontario Air Ambulance;
Brian Hershey	- Air Ambulance Officer, Ministry of Health of Ontario;
LCol. Joseph Paquette	- National Defence Headquarters Search and Rescue;
Capt. Leif Schoenberg	- Rescue Coordination Centre Trenton, Ontario;
Capt. Dale McLaughlin	- Pilot-in-command of Buffalo search aircraft;
Fred Perkins	- Canadian Coast Guard Search and Rescue;
Terence Marchant	- Metropolitan Toronto Police, Emergency Planning Section;
Rene Vienneau	- Transport Canada CFR Specialist;
Jerry Thornton	- Airport Manager, Toronto Island Airport;
Ed King	- Fire Chief, Toronto Island Airport;
Dr. David Elcombe	- Director, Safety Medicine, CASB;
Dr. David McAuliffe	- Forensic Pathologist, Centre for Forensic Sciences;

Dr. Jiri Zamencnik	- Senior Toxicologist, Civil Aviation Medicine, Health and Welfare Canada;
Keven Fehr	- Pharmacologist, Addiction Research Foundation of Ontario;
S/Sgt. Bruce Hales	- Metropolitan Toronto Police Marine Unit;
M/Cpl. Patrick Mercer	- Startech Trenton Search and Rescue Coordination Centre.

GLOSSARY

asl	above sea level
C	Celsius
CFR	Crash Firefighting and Rescue
DF	direction finding
ELT	emergency locator transmitter
EST	eastern standard time
ft	feet
hr	hour(s)
kt	knot(s)
lat	latitude
lb	pound(s)
long	longtitude
MANOPS	Manual of Operations
MHz	megahertz
mi	mile(s)
ml	millilitre(s)
N	north
ng	nanogram(s)
RCC	Rescue Coordination Centre
ROV	remote operated vehicle
RIV	rapid intervention vehicle
THC	tetrahydrocannabinol
TSO	Technical Standard Order
UTC	Coordinated Universal Time
VFR	visual flight rules
VHF	very high frequency
W	west
Z	zulu
°	degree(s)
'	minute(s)
"	second(s)